CHAPTER II

The Thermodynamics of the Steam Turbine

In a turbine where steam is supplied at a definite pressure and temperature, each pound of steam supplied contains a definite quantity of heat which was obtained by the combustion of fuel in the boilers.

As the steam passes through the turbine it expands, with a corresponding fall of pressure, and on leaving the last row of blading is discharged, usually to a condenser, at some definite lower pressure. During this range of expansion, fixed by the initial temperature and pressure and the final discharge pressure, a definite proportion of the total heat energy of the steam becomes available for conversion into mechanical work, and the degree to which the turbine is capable of converting the available expansion energy into useful work represents the efficiency of the turbine.

Roughly speaking, the principle of the conversion of energy in a turbine may be regarded as occurring in two steps. Firstly, the steam is allowed freely to expand, and in doing so the expansion energy liberated produces kinetic energy in the form of a high steam velocity; then secondly, the kinetic energy of the steam is absorbed by the rotating elements of the turbine, and is thereby converted into useful mechanical work.

A general discussion of the thermodynamic basis upon which the design of heat-engines, and therefore steam turbines, proceeds is given in " Applied Heat", Vol. IV, p. 123.

The entropy, a quantity which is much used in discussions of the design of turbines, is explained in Vol. IV, p. 206, while the Mollier diagram is dealt with in the same volume, p. 221.

The Thermodynamic Efficiency of a Turbine (7?).— **The over-all thermodynamic efficiency of a turbine may be defined as the ratio of the useful work delivered at the turbine coupling to the mechanical equivalent of the available heat supplied to the turbine by the steam. When once the value of *n* is known for a steam turbine, it is possible to calculate the amount of steam required to develop the desired power.**

Let H be the heat available from the expansion of i Ib. of steam in the turbine;

37, the thermodynamic efficiency of the turbine;

W, the weight of steam, in pounds per second, supplied to the turbine, i.e. the water-rate.

Then the useful work, in foot-pounds, done by the turbine, per second (U), is given by

i.e. the horse-power (H.P.) is given by ||

j

550 - ; a **H.P. =**

^51,